

Epigenesis and the rationality of nature in William Harvey and Margaret Cavendish

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Received: 17 July 2016 / Accepted: 19 April 2017 / Published online: 24 April 2017
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Abstract The generation of animals was a difficult phenomenon to explain in the seventeenth century, having long been a problem in natural philosophy, theology, and medicine. In this paper, I explore how generation, understood as *epigenesis*, was directly related to an idea of *rational nature*. I examine epigenesis—the idea that the embryo was constructed part-by-part, over time—in the work of two seemingly dissimilar English philosophers: William Harvey, an eclectic Aristotelian, and Margaret Cavendish, a radical materialist. I chart the ways that they understood and explained epigenesis, given their differences in philosophy and ontology. I argue for the importance of ideas of harmony and order in structuring their accounts of generation as a rational process. I link their experiences during the English Civil war to how they see nature as a possible source for the rationality and concord sorely missing in human affairs.

Keywords Epigenesis · William Harvey · Margaret Cavendish · Metaphysics · Explanation · Reason · Aristotelianism · Teleology

1 Introduction

Explaining the generation of animals has long been a problem in natural philosophy, theology, and medicine. Various aspects have been explored by philosophers and physicians as diverse as Aristotle and Jean Fernel, as various as Galen and G. W. Leibniz (see Roger 1963; Richardson 1980; Duchesneau 1997; Hirai 2005, 2011; Smith 2006c, 2011; Cheung 2008). Part of explaining generation was to adequately characterize *how* it occurred: was the fetus constructed part-by-part, over time

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(*epigenesis*)? Did it instead get its form all at once (*metamorphosis*)? Or did that form already exist (*preformation*)?¹

There was, in addition, disagreement over how to *explain* generation. The most difficult characterization to explain was epigenesis, often described not just as complex, but as involving self-construction; the fetus seemed to *make itself*. Such self-movement would prove difficult to accommodate into early modern systems of explanation, in part a result of the abandonment of teleological causation without a concomitant rejection of describing Nature as end-oriented. On this last point, Justin Smith has convincingly argued,

Accounts of fetal development as an end- or idea-driven process were doomed to fall into disfavor in the seventeenth century. However, it would prove much harder to eradicate immaterial, guiding principles of development from embryological explanation than many modern thinkers would have liked. This is because, as the example of Harvey makes very clear, such principles would continue to appear indispensable in the explanation of organic phenomena long after physics, the study of inorganic bodies, had proved, for many, perfectly able to do without them (Smith 2011, 167).

This idea of generation as end-driven came down to a *perceived* need to invoke teleology of some kind in order to provide any sort of reasonable explanation. Indeed, as Smith has argued, these teleological principles seemed necessary not just to explain but even just to *describe* living phenomena.

Epigenesis is thus important to the histories of philosophy and science, not because it is true, but because it presents us with an opportunity to observe the limits of seventeenth century natural philosophy, not just by our standards, but by those of early moderns themselves. Some natural philosophers, such as William Harvey, were keenly aware that their ability to characterize generation as epigenesis outstripped their ability to explain that characterization. Harvey found himself forced into speculation and metaphor as the only means to understand generation (Goldberg 2013). Others, like G. W. Leibniz, argued that the impossibility of explaining epigenesis resulted not from our understanding of fetal development, but from the fact that it was metaphysically impossible that such a process could be the origin of soul or entelechy. He thus argued that certain metaphysical principles decided the case of generation in favor of preformation (see Smith 2006b, c, 2011).² Indeed, across the seventeenth century there was vigorous debate about the modes of explanation necessary to explain *any* complex natural process: was God needed to account for all activity (*Occasionalism*)? Were immaterial spirits needed to guide

¹ While all of these terms are actors' categories at one point or another, I here use them as historians' categories to help organize the plethora of positions we find on issues of generation throughout the early modern period. I purposefully avoid the term "vitalism" because I think it's a misleading category when applied to pre-Stahlian ideas, though I don't have space to argue for this conclusion.

² As Smith notes, Leibniz makes some telling remarks to DeVolder in 1703: "No primitive entelechy whatsoever can ever arise or be destroyed naturally, and no entelechy ever lacks an organic body. As far as my consideration of these matters goes, these things could not be otherwise; they are not derived from our ignorance of the formation of fetuses, but from higher principles" (cited in Smith 2006b, 12).

complex processes (*Platonism/Galenism*)?³ Or were matter and motion enough to explain all of Nature (*Mechanism*)?⁴

In this paper, I explore some of the issues surrounding epigenesis in the context of two English natural philosophers never before discussed together in any detail: William Harvey and Margaret Cavendish. The former has often been considered in discussions of generation; indeed, he most likely introduced “*epigenesis*” from the Greek into Latin medical terminology in his *Exercitationes de generatione animalium* (Harvey 1651, Ex. 45, 121). But he has rarely been considered in the context of philosophical debates about causality, or about the status of minds and matter in the natural world (though see Lennox 2006; also see Smith 2006a). Cavendish has only recently entered our histories of philosophy, thanks to the pioneering work of feminist historians, who have made it clear that her philosophy was important for early modern theories of causality and matter (see McGuire 1978; Sarasohn 1984; Hutton 1997; O’Neill 1998; Battigelli 1998). But her thought has only rarely been considered in the context of debates about generation (though see Sarasohn 2010, 168–169; Walters 2014, 44–45, 85, 132, 225). Importantly, I argue that Harvey and Cavendish, despite profound philosophical differences, offered a similar solution to the problem of explaining epigenesis: both argued that *Nature* was *rational*, and that this rationality allowed us to understand how complex natural objects come to be, namely, by a process analogous to humanity’s own modes of construction. And while Harvey was willing to admit that the vegetative aspect of soul responsible for epigenesis was *more rational* than the rational soul, Cavendish went even further, having proposed not only that Nature was more rational than humanly, but that matter was *itself* active and rational.

The paper will proceed as follows: I begin in Sect. 2 by motivating the comparison of these two philosophers by providing some relevant context. In Sect. 3, I describe Harvey’s account of epigenesis and explanation, followed in Sect. 4 with a discussion of Cavendish’s account. Finally, I conclude in Sect. 5 by comparing and contrasting their conceptions of the rationality of Nature, placing these ideas in the context of changing notions of the soul in the early modern period.

2 Science and politics, epigenesis and England

William Harvey (1578–1657) was an English physician, most famous for his anatomical demonstration of the circulation of the blood (Harvey 1628). He was considered a hero by many of the new philosophers, including many founders of the Royal Society, upon whose experimentalism he had a profound and lasting impact. Indeed, Robert Frank (1980) has argued that one of the main objects of the Royal Society’s early research was the set of physiological problems caused by Harvey’s discovery of circulation, and the ensuing undermining of the Galenic/Aristotelian

³ Others might label this “vitalism,” but, again, I find this to be a misleading term here. In particular, ‘vitalism’ does not adequately distinguish the distinct positions of Aristotelians and Platonists/Galenists on the need for supernatural spirits, as both groups affirmed the importance of vital matter (and heat).

⁴ These positions are in no way meant to be exhaustive.

interpretation of the parts of the body. Despite Harvey's experimentalism, his philosophy of science opposed much of the agenda of canonical early modern philosophers like Descartes: Harvey was a committed, if eclectic, Aristotelian (Pagel 1967, 1976; Gregory 2001; Lennox 2006; Goldberg 2012). His theories of matter, causality, explanation, and metaphysics were deeply at odds with the new material and mechanical philosophies.

Margaret Cavendish, Duchess of Newcastle (1623–1673) has not, until recently, fit into our accounts of early modern natural philosophy, though thankfully there is now a great deal of work on Cavendish (see especially Sarasohn 2010; Walters 2014). Leaving England and becoming a member of Henrietta Maria's court-in-exile in 1644, she met and eventually married William Cavendish, who had fled abroad after having lost the battle at Marston Moore. It was there that Cavendish began writing, with the support of her husband, living in exile until 1660. Her husband was a patron of Hobbes, and interacted with Descartes and other *novatores*, though for reasons of gender and culture, Cavendish herself never directly talked with any of them (see Sarasohn 2010, 2–4). Among her far-reaching works are plays, poems, as well as natural philosophical treatises. Cavendish has also become well-known for her philosophy of matter, which embraced not just a thoroughgoing materialism, but also the idea that all of Nature was truly rational, even down to the parts of matter itself (see James 1999; Sarasohn 2010).

Let us now return to the topic of epigenesis. Harvey took epigenesis to have been established empirically, through his painstaking observations of chickens, deer, and other animals (Ekholm 2008). Cavendish took onboard descriptions similar in broad outline to Harvey's account, further making speculative arguments about generation based on the metaphysics of matter. Both seemed to realize that, if epigenesis were the correct description of generation, there would be profound implications; upon these rocks Descartes' ship would founder, matter and motion alone were unable to adequately account for generation. And if some form of materialism were true—as some began to argue, including Cavendish—then epigenesis, because of its orderliness, its complexity, and its directionality, implied that matter might not be entirely passive, or that there must be some other active principle responsible. Not even Harvey's deeply teleological system was truly satisfying in explaining epigenesis, even by his own standards (Harvey 1651, 292–293; see also Müller-Wille and Rheinberger 2012).

As is so often the case, political and social context can help us understand a great deal about the ideas of natural philosophers. This is especially true in the politically and religiously turbulent period in England prior to the Glorious Revolution in 1688.⁵ John Rogers (1998) has described a “vitalist moment” of Harvey, Marvell, Milton, and Cavendish, whose politics and philosophies intersected in important ways, affecting both how and what they thought. Though I here avoid the label “vitalist,” Rogers is surely right in identifying the political instability of mid-century England as having had a profound impact on English philosophy. Harvey and Cavendish were, in particular, deeply affected by the Civil War. Harvey's

⁵ The Glorious Revolution did not, of course, end all turbulence, and Jacobite uprisings continued until the 1740s.

royalism resulted in his being declared a “delinquent,” a £2000 fine, and a burglary that robbed him of many of his notes, papers, and possessions (Whitteridge 1981, xxii; for some additional context, see the debate between Hill 1964 and Whitteridge 1965; for more on the social context see also Keller 1998). Cavendish spent a good deal of her life in exile, her husband never able to claim the position or power he held before the war, and both were scarred by the effects that the changing social hierarchy had upon them (Sarasohn 2010, 20, 70–72).

Rogers has identified an important link between natural philosophy and English politics in the close relationship between new theories of active matter and the development of post-Civil War English intellectual and civil society.⁶ Both Cavendish and Harvey were politically conservative thinkers—Royalists to some extent—and both proposed what were, at the time, somewhat radical ideas. Cavendish argued that matter was *itself* rational and self-moving, while Harvey argued for the natural philosophical primacy of *autopsia*, that is, personal experience.^{7,8} While these ideas are quite different, as were the thinkers that proposed them, we find that we can unite their concepts through a shared desire to foster harmony and order by means of natural philosophy.⁹ This was a radical idea: to use science as a means of ensuring the stability of English society, to use Nature’s orderliness as a solid foundation upon which to build consensus (this was, of course, a core insight of Schaffer and Shapin 1985; see also Shapin 1996). French (1994) has argued that the English context and the Civil War were deeply important to Harvey’s experimentalism and its influence on mid-century English natural philosophy. He has traced a connection between the economic and political justification of allowing only physicians sanctioned by the Royal College to practice medicine, and the experimentalism found especially in Harvey’s work. Experimentalism played an important role in politically and epistemically legitimizing the traditional medical establishment over and above chemical and other new forms of medicine in the period leading to the Civil War (French 1994, 341–342). After the Civil War, not just in the Royal College of Physicians but also in the Royal Society, this very-same experimentalism came to be seen as a way of forging consensus in a time of disagreement about not just natural philosophy, but also about religion and politics (Schaffer and Shapin 1985). Thus Nature and politics might be usefully linked in Harvey’s work as a means of fostering social order and philosophical

⁶ Rogers uses the term “vital” matter, but I think “active” is a less contentious and more accurate way of categorizing these theories.

⁷ Cavendish’s exact political stance is hard to categorize, however; see Rogers (1998, 177–212), Rees (2003, 149), and Walters (2014, 27–32).

⁸ While Harvey’s experimentalism soon becomes an orthodox position that Cavendish herself argued against in her *Observations upon Experimental Philosophy*, Cavendish’s ideas did not come to be nearly so quickly accepted. Her ideas were similar to those of some of the Cambridge Platonists, such as Henry More, who emphasized the importance of self-activity and motion in understanding especially living things. Of course, More was deeply concerned with *immaterial* substances, something explicitly rejected by Cavendish, who, indeed, spent a good deal of time specifically arguing against More’s doctrines. On Harvey’s experimentalism and its influence, see Frank (1980). On Cavendish and More, see Hutton (2003).

⁹ On order and harmony in Harvey, see Goldberg (2013); for Cavendish, see Walters (2014), who discusses in detail the importance of politics throughout Cavendish’s works.

agreement. Here I argue that, beyond his experimentalism, we can see some related ideas that connect the political to the scientific in Harvey's struggle to explain generation by epigenesis. Indeed, his notion of the intrinsic rationality of the vegetative soul (the lowest order of the soul) is similar in many respects to the ideas we see in Cavendish having to do with active, rational matter. Both thinkers prize the harmonious way in which natural things perform their tasks without the conflict so obvious in human affairs.

While Cavendish's philosophy was (at least by the time of the *Observations*) an anti-experimental one, we find a desire similar to Harvey's in her attempt to ground social harmony in the natural order. Cavendish, like Harvey and many others in the early modern period, drew upon ideas of the microcosm (the human body), to understand the macrocosm (here the political state), and vice versa. Thus, we see in her *Animal Parliament* (1668) an attempt to chart a course between King and Parliament via analogies with the living body and the living cosmos. As Lisa Walters has argued, Cavendish allowed that some rebellion was healthy and natural in the functioning body politic, just as disagreement between bodily humors was quite normal and natural. In both cases, disagreement, so long as it was adjudicated rationally, tended to lead to a new stable and harmonious situation (2014, 27–28). Thus, Cavendish linked Nature to politics, and the ability of Nature to foster harmonious and stable relations between different parts to a possible state that fosters such relations between king and parliament, noble and peasant.

These two members of Rogers' "vitalist moment" were thus united not just by specific views of the Nature of living things, but also by a desire to use the order of Nature to allow for, perhaps even create, stability in English society and politics. This concern brings us to a central object of this essay: the idea that Nature was itself rational. In a country that had gone mad, where peasant fought noble, where subjects abandoned and took up arms against their King, it seemed reasonable to hope for order in the world, especially among those deeply affected by the Civil War. There was, furthermore, need for that order to depend, not on volatile humanity, but upon more solid grounds. Since our human world could not be rational, despite our possession of so-called "rational souls," Harvey and Cavendish turned to Nature itself as a source of true—even *superior*—rationality. Nature's power in generation verged on the inspirational; even the basest ingredients could be turned into the most divine living creatures, in a process more disciplined and regular than a column of marching soldiers. Nature's order gave hope for social order, and there was thus both a philosophical and social connection between Harvey and Cavendish's accounts of epigenesis as an inherently rational, natural process.

It is surely too simple, and goes much too far, to claim that this was the origin of their ideas. The connection between their politics and philosophy was somewhat more abstract and ambiguous than any direct causal relation. But, still, there was a connection. Thus, understanding the importance of the post-Civil War desire for order and harmony in the English context helps not just to motivate our comparison of these two thinkers, but also provides an important justification to focus upon these concepts of order and harmony. These issues, in particular, will allow us to see

a deep connection between Cavendish's and Harvey's accounts of generation by epigenesis.

3 Harvey on generation

Harvey's theory of generation was essentially an updated, slightly Christianized, more empirically and anatomically nuanced version of Aristotle's (Lennox 2006; Goldberg 2012). His *Exercitationes de generatione animalium* (1651) became a cornerstone of embryological research for (at least) 50 years after his death—a testament to the quality of his empirical work, especially given the *subsequent* rise of microscopy. Given that Harvey's conception of generation was heavily influenced by his empirical findings, it should not be surprising that it was this aspect of Harvey's work that proved to have a lasting influence: the part readily accepted, if not always agreed with, by *novatores* and experimental philosophers. Witness a 1674 edition of Harvey's *De generatione* published in Amsterdam by a Dutch physician named Justus Schrader: he excised all the "philosophical" parts and left only the "empirical parts" (Pomata 2005, 121–122; Schrader 1674, *praeformatio*).

One of Harvey's most important contentions was that he had found no material present in the womb post-coitus (Keller 1998; Goldberg 2013). How the first conception arose (that is, out of what material it was made) became a difficult problem, made worse by his description of the *conceptus* as entirely homogenous. These findings ruled out any theory that depended on there being some matter in the womb that received from the male either the form necessary for development, or some nutriment or matter necessary for the growth of the fetus. Harvey believed that he had anatomically demonstrated that the form and matter of the fetus came to be simultaneously. Now, of course, Harvey was wrong here (and on much else), largely stemming from an ignorance of microscopy; the limits of his eyes were the limits of his ontology. Thus, he saw neither sperm nor any sign of it in the womb after coitus, nor could he observe the structure of the earliest stages of the embryo, nor, later, could he see the tiny, nigh-on-invisible chambers of the heart after the endocardial tubes had merged and looped, mistaking them for a speck of moving blood, the *punctum sanguinum saliens* (Harvey 1651, Ex. 17, 49–50). This last observation helped to cement his argument that self-moving blood preexisted the heart, and formed the first genital particle of the embryo, out of which all the rest of the fetus came to be by *epigenesis*—part by part, over time. Harvey opposed epigenesis not with the idea of preformation that would come to dominate late seventeenth and eighteenth century European discussions, but rather with what he called *metamorphosis* (Harvey 1651, Ex. 45, 121). The difference between metamorphosis and preformation was that, in the former, the embryo had no form and received it all at once, like a stamp. In preformation (not mentioned by Harvey), the embryo must have always had the form of the adult, changing only in size.

In epigenesis, the parts were made and formed, one after another. This process of coming into being was complicated, as it was a process both by which a part comes into existence *and* grows, a process of generation *and* nutrition (Harvey 1651, Ex.

45, 122). Matter here seemed to organize *itself* into parts, moving from homogenous to heterogeneous. Here we find a point in common between Harvey and Cavendish, one with those politically important consequences discussed above. Both characterized Nature as having some sort of power of self-movement and activity, this movement regularly organizing matter into harmonious, well-functioning living beings. In order for harmony to be achieved, these processes had to occur over time, in a specific order—for example, it would be quite unharmonious for the skull to come into being before the brain. Harvey’s account is thus one that was both exceedingly *complex* and yet consistently *regular*.

Given this understanding of generation, there were some important concepts that Harvey invoked. The most important of these was the soul, as developed by Aristotle and Galen and in the ensuing medical and philosophical traditions of the Renaissance (Park 1988; Wolfe and van Esveld 2014). It will be helpful to go over these ideas, since, as I will discuss in the conclusion, Cavendish had abandoned this conception of soul, leading to a fundamental—but quite interesting—misreading of Harvey. Aristotle defined soul as, “... the cause and principle of the living body...the soul is defined by the three ways something is called a cause: it is the cause of movement, it is the cause for the sake of which, and the soul is the cause of the living body, as its substance” (Aristotle 1552a, *De anima*, Lib. II, Cap. 4, 68).¹⁰ The soul, then, was a sort of triune cause: it was the formal, final, and efficient cause of all the activities, parts, and organization of the body, whose matter was entirely passive until (literally) *organized* by soul, coming to be in a process of gradual emergence.

Following Aristotle, Harvey saw reason and definition as central to his project. In the *Organon*, Aristotle argued that a statement of the form of a thing was a definition of that thing, and thus definition of a thing was understood as a reason that signified an essence (see Aristotle 1552c, *Topicorum*, Lib. I Cap. 4, 257). Thus, we find that the Latin *ratio* (literally “reason”) was used to denote a scientific definition (see Aristotle 1552b, *Meteorologicorum*, Lib. IV, Cap. 12, 222).¹¹ The form of a thing, its essence, determined the Nature of that thing, including its functionality; in living things, this was their soul. The essence of a natural thing was the sum cause of its powers and activities. Thus, the soul was seen to be the cause of the various processes of living creatures, and was further subdivided into various parts that had different sets of powers. The most basic aspect of soul was the vegetative, responsible for maintaining the body as well as for generation; one step higher was the sensitive soul, responsible for perception and movement in animals. And finally, there was the rational soul, found only in humans. Importantly, since the powers of a

¹⁰ I here quote and translate from the 1552 Venice Aristotle-Averroes edition which Harvey is known to have used. “Est autem anima viventis corporis causa and principium...anima secundum determinatos tres modos causa dicitur: etenim unde motus causa est and cuius causa and sicut substantia animatorum corporum anima causa.” Or as Averroes wrote, “...the soul is a cause according to the three determined senses: it is the moving cause, it is the final cause, and it is the formal cause” (Averroes commentary in Aristotle 1552a, *De Anima* Lib. II, Cap. III, 68v). “...anima est causa secundum tres modos determinatos, scilicet causa movens, finalis, and formalis...”

¹¹ Whitteridge’s (1981) translation of Harvey’s *De generatione* translates *ratio* as “concept,” and while this term is suggestive, I hope to steer a somewhat safer course by sticking with the less objectionable “definition” or “reason.”

thing were inherent to what it was (that is, part of its Nature), natural change, including generation, could be thought of as self-induced change, at least by the time of the first conception of the fetus. Most importantly for our purposes, Harvey used *rationes* in order to understand the complex process of embryological development. (Importantly, he offered a somewhat radical reinterpretation of the status of its most basic vegetative aspect, about which more below.) With these concepts in hand, we can now turn to epigenesis.

Epigenesis ended in the creation of a union of soul and body, functions and parts, all according to the *ratio* of the animal. Harvey, in describing how the soul (here its formative faculty) was responsible for the construction of the fetus during development, articulated a process of progressive self-formation:

...all the parts are not fashioned at the same time, but emerge successively and in order; while the fetus is increasing, it is being formed, and while it is being formed, it is increasing; and some parts are generated upon others that existed before, and are divided from them...The formative faculty of the chick takes the material to itself and prepares it, rather than finding it prepared, and the chick seems less to be made or increased by another than by its own self. And as all these things are given increase by that very thing from which they are made, so too it is to be believed that the chick is conserved and given increase from its beginning by the very same thing by which it was made (be it the soul or a faculty of the soul). For the same efficient and conserving power is now found in the egg, now in the chick, and it constitutes the first particle of the chick out of the very same material with which it nourishes, increases, and adds all the rest of the parts (Harvey 1651, Ex. 45, 122–123).¹²

Note two things: first, Harvey identified the “efficient and conserving power”—the soul—as responsible for the preparation and creation of the egg and the chick during development. Second, generation was a process where the chick gradually came to have the shape of the adult organism, “successively and in order.” But, importantly, this shape, this form, was *functional*: it was teleologically organized according to the needs of the animal being generated, such that after birth the offspring could live on its own. Thus, generation was understood just as in Aristotle, as a process of generative emergence. As James Lennox has explained,

At the simplest level, there is the generative emergence of many uniform parts from a single one. But due to the temporally and spatially coordinated character of this emergence, parts of a more complex kind emerge, the nonuniform instrumental parts. Each of these, moreover, comes to be as and when it does in order to play its role in a coordinated and hierarchically

¹² ...neque omnes ejus partes simul fabricari, sed successive, atque ordine emergere; eundemque simul, dum augetur, formari; and augeri, dum formatur; partesque alias aliis prioribus supergenerari and distingui...Facultas enim pulli formatrix materiam potius sibi acquirit, and parat; quam paratam invenit: videturque pullus haud ab alio fieri, vel augeri, quam a se ipso. Et quemadmodum omnia, ex quo fiunt, ab eodem augentur: ita similiter a quo pullus conservatur, and augetur ab initio (sive id anima, sive facultas animae fuerit) ab eodem quoque...eum fieri credibile est. Idem enim reperitur tum in ovo, tum in pullo, efficiens, ac conservans; and ex qua materia primam pulli particulam constituit, ex eadem nutrit, auget, and superaddit reliquias omnes.

organized set of living capacities. That is, not only is there a generative emergence of a complex structure from a simple and uniform material, there is also the generative emergence of a living being, an *empsychon*. Moreover, soul emerges in stages: the earliest stages of the embryo have nutritive soul, and “as they progress they have also perceptive soul in virtue of which they are animals” (GA II. 3 736b1–2). To understand biological development in Aristotelian terms is to conceive of it as the goal-directed actualization of a potential, as the gradual, continuous emergence of a complexly structured, functioning living being (Lennox 2006, 28).

Indeed, Harvey followed Aristotle on just this point about the time-ordered emergence of soul and function (Harvey 1651, Ex. 26, 79). Generation was seen as the construction of the soul-body union, part by part, and, as each organ was constructed, another aspect of soul and its instruments came into being.

The vegetative soul was the most basic aspect of soul potentiality, and formed the foundation of Harvey’s explanation, temporally and causally. As we shall see below, epigenesis was part of the reason that Harvey claimed that the vegetative part of the soul was in some way rational. Indeed, Harvey seemed to argue that it was *super-rational*:

...that the vegetative faculty, or that part of the soul that makes and conserves a man, is by far more excellent and more divine and more nearly resembles God than the rational part of the soul, whose excellence nevertheless we extol with wondrous praises above all the faculties of all animals, as though it held law and authority over the others, and as though all created things were subservient to it. Or then we must confess that, in the works of Nature, there is neither foresight, nor skill, nor understanding, but they seem such only to our concepts, which judge the divine productions of Nature by our own arts and faculties... (Harvey 1651, Ex. 50, 145–146).¹³

In particular, Harvey argued that the vegetative soul of the blood took the role that had been occupied by the heart, which organ Aristotle identified in his *De generatione* as the first principle of the embryo. For Aristotle and for Harvey, what made for the first genital part was that it was causally independent of the mother and father, that is, it made the fetus into its own self-directed creature, whose activity in this case was the construction of the organic body by epigenesis. That is, the fetus directed its own construction, and did so, according to Harvey, in a wise and knowing way.

By the time of Harvey’s work on generation, midway through the seventeenth century, there were a proliferation of *spiritus* and *facultates* that were deployed in various physiological contexts to explain the seemingly self-directed, self-moving activities of living things, especially to explain the complicated process of

¹³ “...facultatem vegetativam, sive eam animae partem, quae hominem fabricat, and conservat, multo excellentiorem, and diviniorem esse, magisque similitudinem Dei referre, quam partem ejus rationalem; cujus tamen excellentiam miris laudibus supra omnes omnium animalium facultates extollimus; tanquam quae ius and imperium in illas obtineat, cuique cuncta creata famulentur. Vel saltem fatendum est, in naturae operibus, nec prudentiam, nec artificium, neque intellectum inesse: sed ita solum videri conceptui nostro, qui secundum artes nostras and facultates...de rebus naturae divinis judicamus....”

embryological development (Hirai 2005, 2007, 2011).¹⁴ In the work of some of Harvey's sources, such as Fernel and Scaliger, these spirits acted as intermediaries of sorts, between the mortal body and the divine soul, their status indeterminate between the poles of material and immaterial. Harvey singled these two out for criticism on just this point of the status of the spirits. Harvey argued on basically Ockhamian grounds that instead of multiplying these intermediary spirits without end, one could simply posit the blood—in particular, the living blood—as the vehicle of the soul in the body, as, in effect, the *ratio* that directed the creation of the embryo towards the form of the completed offspring (Harvey 1651, Ex. 71, 244–245). Thus, the vegetative faculty of soul, in the blood and in its creation of the embryo, displayed a kind of rationality that went far beyond not just the material ingredients of generation, but far beyond human reason itself. It was as like to God's rationality as we might hope to witness.

4 Cavendish on generation

The origin and sources of Cavendish's concept of generation are obscure. What we do know is that she did no experiments herself, instead, as she mentions in *Observations*, she relied on “sense and reason.” We know further that this would *not* include microscopes, as she rejected the possibility that “dioptrical” glasses could ever make her change her opinion (Cavendish 1666, 50). Instead, her conception of generation seems to have been based on speculative rational arguments about conceivability and necessity (on Cavendish as rationalist, see Lewis 2001; Broad 2002; Detlefsen 2007).¹⁵ She was certainly influenced by other accounts of generation, including Harvey's, but her specific sources are hard to reconstruct. Indeed, her account of generation was orders of magnitude less detailed and complicated in comparison to Harvey's—though given the latter's profession and experience this is not surprising. But it was reasonably clear that Cavendish took generation seriously. She invoked it in a variety of argumentative contexts, for example, in a disagreement with Hobbes (cf. *Leviathan* 1.c.4):

I surely believe, that there is more understanding in Nature, then that, which is in speech, for if there were not, I cannot conceive, how all the exact forms in Generations could be produced, or how there could be such distinct degrees of several sorts and kinds of Creatures, or distinctions of times and seasons, and so many exact motions and figures in Nature... (Cavendish 1664, 38).

Generation was thus among a number of orderly, complex processes in Nature that were difficult to explain. The argument here was typical of those throughout her

¹⁴ I note that a good deal of the empirical work and writing for Harvey's *De generatione* was done earlier, some as early as perhaps the 1620s, the majority being performed in the 1630 and 1640s. For more detail, see Keynes (1966).

¹⁵ Peter Anstey and his group have been developing a new categorization of early modern philosophy, one that replaces “rationalist” and “empiricist” with “speculative” and “experimental.” Anstey has argued that Cavendish fits quite well into the ‘speculative’ category, for which see Anstey (2014). I thank Kirsten Walsh for this reference.

work: making a claim, here about the amount of understanding in Nature, and then arguing by a kind of quasi-*reductio ab absurdum*, wherein, on the assumption that the claims were not true, we would be reduced, not to a logical impossibility, but to an explanatory or conceptual impossibility. That is, without assuming that there is an adequate amount of true understanding in Nature, it would be impossible to conceive of the phenomena of generation at all; we could not understand how these forms and kinds came to exist.

Though she talked about generation often, she never actually used the term “epigenesis.” Despite this, it seems clear that she understood generation to happen in terms of epigenesis:

But yet I cannot believe, that some sorts of creatures should be produced on a sudden by the way of transmigration or translation of parts, which is the most usual way of natural productions; for both natural and artificial productions are performed by degrees, which requires time, and is not done in an instant (Cavendish 1666, 67).¹⁶

Note especially the temporal element of “by degrees”, which as we saw above in Harvey, was fundamental to his characterization. This must refer to epigenesis, as all other characterizations of generation available described it as either happening “all at once” as in metamorphosis, or as depending on preexisting form, as in preformation. We can further demonstrate that Harvey has had some influence on her thinking about the generation of animals, insofar as she took the time to argue, in print, against his positions. This is most visible in her use of “metamorphosis” in the *Observations* and in the *Philosophical Letters*, where, indeed, she directly addressed a number of Harvey’s ideas about generation (Cavendish 1666, 54, 65, 67–68; Cavendish 1664, 419–432).

In particular, Cavendish responded to Harvey’s descriptions of metamorphosis and epigenesis, and asked “*Whether an Animal Creature is perfectly shaped or formed at the first Conception?*” She rejected this characterization of generation entirely, arguing that:

If the Creature be composed of many and different parts, my opinions is, it cannot be. You may say, That if it hath not all his parts produced at once, there will be required many acts of generation to beget or produce every part, otherwise the producers would not be the Parents of the produced in whole, but in part. I answer: The Producer is the designer, architect, and founder of the whole Creature produced; for the sensitive and rational corporeal motions, which are transferred from the producer or producers, joyn to build the produced like to the producer in species, but the transferred parts may be invisible and insensible to humane Creatures, both through their purity and little quantity, until the produced is framed to some visible degree; for a stately

¹⁶ Also see one of her (many) prefaces to her 1666, the one entitled “An Argumental Discourse,” where she writes, “...other-wise the creatures which Nature produces, would all be produced alike, and in an instant; for example, a Child in the Womb would as suddenly be framed, as it is figured in the mind; and a man would be as sud-denly dissolved as a thought: But sense and reason per-ceives that it is otherwise; to wit, that such figures as are made of the grosser parts of Matter, are made by de-grees, and not in an instant of time...” (no pagination).

building may proceed from a small beginning, neither can humane sense tell what manner of building is designed at the first foundation (Cavendish 1664, 423–424).

Given the discussion of Harvey above, this proves to be an important passage. Let me note first some differences and similarities. As for the latter, Cavendish was clearly committed to epigenesis in that the parts are not produced all at once—she remains consistent in arguing, as Harvey did, that acts of generation take time, and start with some tiny frame upon which the rest of the body is built. Further, her language of “designer, architect, and founder” echoed Harvey’s own language as was used describe epigenesis, and especially characterize its complexity (see, for instance, his discussion of God as the “Divine Architect” in Ex. 11 of his 1651, as well as his discussion in the short treatise appended to that work, *De conceptione*).

As for differences, Cavendish, unlike Harvey, had no problem accepting the idea of parts insensible to human sight, for, as a consequence of her speculative arguments, she accepted the idea of “infinite matter.” Further, Harvey’s detailed anatomical observations and arguments were quite different from Cavendish’s speculative arguments about the nature of matter and causality. She rejected whole swaths of Harvey’s account, while accepting the broad, empirically established contours of the process of epigenesis (thus in keeping with the historical trajectory of the reception of Harvey’s *De generatione* noted above). She rejected especially those parts of Harvey’s account that (she claimed) involved immaterial substances, spirits, and principles, his ideas about the blood being the first part of the body, as well as his analogy between brain and womb (Smith 2006c; Goldberg 2013). Yet further, she could reject his seemingly empirical result of no material in the womb after conception by making reference to the possible existence of insensible bits of matter, also undermining his account of the first foundation of the embryo as entirely homogenous (Cavendish 1664, 419–420). She thus seems to have rejected much of Harvey’s explanation of epigenesis, including, importantly, his ideas of soul. In the work of others, such as Leibniz, such rejections combined with ideas of the *plenum* would allow for an idea of preformation to flourish. However, I argue here that Cavendish and Harvey’s positions are much closer than Cavendish realized, despite differences in ontology. I return to this in the final section below.

Whereas Harvey’s ideas were old-fashioned for this period, Cavendish’s were—and perhaps still are—quite radical. The key here, as in Harvey, was an idea of self-movement. But instead of depending upon the powers of the soul, Cavendish argued that matter was inherently capable of directing itself, her position monistic even down to affirming that the mind and its conceptions were themselves material (and *only* material) (Cavendish 1664, 422). This was a rather unpopular opinion in much Western metaphysics, which often tended to treat matter in one of two ways up to the early modern period: Plato’s (and post-Augustinian Christians’) conception of matter as something fundamentally *inferior* to the Forms of true reality; and Aristotle’s more moderate idea that matter was an abstraction, incomplete without an active form to complement its passivity. With Descartes’ dualism, matter was reduced yet further, now entirely passive, devoid of active form, moved only by impact, and guided, not by form, but by laws of Nature.

It is true, of course, that other English philosophers in this period asserted the importance of self-movement. However, these ideas attributed such self-activity only to *immaterial* substances or principles, such as Henry More's *Hylarchic Principle* (on More, see Henry 1986; Reid 2012). There were a variety of reasons why More and others limited self-activity to immaterial substances alone, but many depended on the post-Cartesian assumption that matter was *necessarily* inert, and that self-active matter was thus a contradiction. So, for instance, More argued that if matter were self-active, there would be no way for it to stop itself (More 1662, II, 21, 31). John Henry has persuasively argued that More realized that the only threat to his dualistic system (matter and an active, immaterial principle) was a theory of self-active matter (Henry 1986, 175–176). As Sarah Hutton and others have argued, it was just this sort of theory that Cavendish offered, in part to address problems she saw in both Hobbes' materialism and More's immaterialism (Hutton 1997, 426; see also Hutton 2003; James 1999). The traditional link between materialism and atheism made self-moving matter a much more radical option than self-moving immaterial principles, making Cavendish's position an infrequently occupied one, especially in the context of mid-century English philosophy, where theological issues and the specter of atheism played an important role (Sheppard 2015).

Cavendish thus ascribed activity to something that had been seen as merely a *patient*, giving independence to something that had almost always been claimed *dependent*. In her response to More's ideas about the laws of Nature in his *Antidote against Atheism* (2.2–3), she wrote that,

...there is nothing in Nature but what is material; but he that thinks it absurd to say, the World is composed of meer self-moving Matter, may consider, that it is more absurd to believe Immaterial substances or spirits in Nature, as also a spirit of Nature, which is the Vicarious power of God upon Matter; For why should it not be as probable, that God did give Matter a self-moving power to her self, as to have made another Creature to govern her? For Nature is not a Babe, or Child, to need such a Spiritual Nurse, to teach her to go, or to move; neither is she so young a Lady as to have need of a Governess, for surely she can govern her self; she needs not a Guardian for fear she should run away with a younger Brother, or one that cannot make her a Jointure (Cavendish 1664, 149).

So Nature was wholly material and yet entirely self-governing. Now, though Cavendish found much to disagree with in Harvey—in particular, his loose use of the term “spirits”—they ended up making a similar argument. In the *Philosophical Letters* and in the *Observations Upon Experimental Philosophy*, among other places, Cavendish argued that it was unnecessary to suppose that immaterial substances were needed to accomplish natural activities. Nature, equipped by God, needed nothing above and beyond herself, as “Nature moveth not by force, but freely” (Cavendish 1664, 23; see also Walters 2014, 62). Nature—understood as infinite matter—was independent and did not rely upon the intervention of impossible (for Cavendish) non-material substances (Cavendish 1666, 211, 219–220). Instead of immaterial substances, Nature had the power of self-motion; she notes that she does not say, “...that Nature has her self-moving power of

herself, or by chance, but that it comes from God the Author of Nature” (Cavendish 1666, 220). In the living world, there was no need for any guardian spirits or immaterial guides, since “...Nature hath power from God to produce all kinds of Vegetables, Minerals, Elements, Animals, and other sorts of Creatures...” (Cavendish 1664, 192; see also Walters 2014, 69–70). Harvey, meanwhile, had argued that there was no need for spirits above and beyond the blood, which was the bearer and instrument of the vegetative soul (Harvey 1651, Ex. 71, 244–245). Cavendish’s conclusions were much broader, but they both invoke parsimony as an important condition for the relationship between God and the powers of natural objects. Both argued that it was much simpler to understand these objects as having causal independence than to multiply spirits and Divine causes. In particular, epigenesis was just such a case where the idea that natural objects had real, independent causal powers made for a simpler explanation than to invoke immaterial principles.

Cavendish’s materialism, and her related denial of immaterial spirits, along with her assertion of the perspective of “infinite and onely matter,” seemed to have almost naturally lead her to assert the rationality of matter. In this she goes far beyond Harvey and ascribed rational activity directly to matter *qua* matter (and not matter *qua* form or soul). Her conception of matter was thus, at bottom, one where its fundamental passivity has been reconceptualized as activity. Thus, phenomena like the self-forming process of epigenesis were no longer inexplicable or absurd; on the contrary, they started to seem like the best sorts of reasons to adopt Cavendish’s position!

For Cavendish, the existence of epigenesis and other kinds of self-moving systems implied that matter must be wise and knowing, rational:

Nature is neither blind nor dumb, nor any ways defective, but infinitely wise and knowing; for ... there is no defect in self-moving matter, nor in her actions in general; and it is absurd to conceive the Generality of wisdom according to an Irregular effect or defect of a particular Creature; for the General actions of Nature are both life and knowledge, which are the architects of all Creatures, and know better how to frame all kinds and sorts of Creatures then man can conceive (Cavendish 1664, 151–52).

Thus, for the process of generation, reason was necessary to account for complexity and order, without such Nature would not create distinct kinds of creatures regularly:

...if there were not Knowledge in all Generations or Productions, there could not any distinct Creature be made or produced, for then all Generations would be confusedly mixt, neither would there be any distinct kinds or sorts of Creatures, nor no different Faculties, Properties, and the Like (Cavendish 1664, 45).

Indeed, for Cavendish, as we saw for Harvey, Nature was sometimes thought to be *super* rational, or at least wiser than many humans. In her *Philosophical Letters*, she wrote,

...it is very probable, that not onely all the Matter in the World or Universe hath Sense, but also Reason; and that the sensitive part of the matter is the builder, and the rational the designer...all parts of Nature are not bound to have heads or tayls; but if they have, surely they are wiser than many a man is... (Cavendish 1664, 151).

This wisdom was essential for Cavendish's conception of Nature, without which none of its complex products could be created. Thus her descriptions of Nature invoked governing or leading or running a noble household, that is, they invoked having and using the wisdom necessary for complex natural process: e.g.: Nature was a "wise and provident lady" in charge of the members of her household (Cavendish 1666, 105); Nature was a "Monarchess over all her Creatures" (Cavendish 1664, 337); Nature had "Wisdom" by which she "orders and regulates her Corporeal Figurative Motions, into kinds and sorts of Societies and Conjunctions" (Cavendish 1668, 32). Deborah Boyle (2013) has argued that, for Cavendish, the parts of matter were parts of a whole, a system that operated, for the most part, according to certain principles designed to produce peace and stability through wise actions, even if individual parts might sometimes have seemed to act counter to this.

It's important that Nature was orderly, but not always and entirely so: Cavendish does admit disorder; indeed, it was central to her account of matter. These disorders were real enough to have effects: disease was such an irregular motion, and so too was civil war (Cavendish 1668, 112 and *passim*; see also: Detlefsen 2007, 176, n. 30). This does nothing, however, to undermine the point here, for, while Cavendish seemed to deny that the overarching wisdom of Nature was *always* orderly, she did affirm that there was an overarching law that Nature always *tended toward order* (Detlefsen 2007). Thus, specific conglomerations of matter must be seen as rational, or the overarching law would not work. And again, we see how the political background to mid-century English philosophy can help us make sense of this desire for order and rationality to be grounded in Nature itself.

5 Conclusion: wisdom and soul

I have argued that both Harvey and Cavendish understood Nature's activities as truly rational, asserting that there really was foresight and planning in Nature. This foresight was found especially in epigenesis, whose elements acted akin to how an artist might in creating some work; in fact, Nature acted with *more wisdom* than that expressed in human art. Importantly, both of their philosophies depended upon what we might label a "pre-modern" conception of the relation between Nature and Art: the former was metaphysically prior, and superior to, the latter. Viewing Nature in this way was central to their rejections of mechanism as a theory of natural causality. Cavendish rejected it, in part, because she thought it could not account at all for phenomena like epigenesis; or, perhaps more accurately, given that she rejected mechanism, the inability of mechanists to adequately account for epigenesis was a point in her favor. Harvey rejected mechanism because it was incomplete: it paid attention to only half the causal story, ignoring the necessary

teleological aspects of generation, without which epigenesis could not at all be understood. It was obvious to him that understanding epigenesis meant understanding it in terms of how the efficient and material causes completed the final cause of the offspring. Without this complex set of real, natural ends, the complexity and regularity of epigenesis would not exist.

As noted, both Harvey and Cavendish modeled the natural production of epigenesis on artistic production. This was, of course, a common model in both the ancient and early modern worlds, but it was also one whose ontological interpretation was (eventually) inverted in the wake of Descartes' work. Cavendish argued that, in generation, we see a process like unto our own art; in fact, somehow more perfect in its execution and contrivances:

Nevertheless she [Nature] is more wise then any Particular Creature or part can conceive, which is the cause that Man thinks Nature's wise, subtil and lively actions, are as his own gross actions, conceiving them to be con-strained and turbulent, not free and easie, as well as wise and knowing; Whereas Nature's Creating, Generating and Producing actions are by an easie connexion of parts to parts, without Counterbuffs, Joggs and Jolts, producing a particular figure by degrees, and in order and method, as humane sense and reason may well perceive: And why may not the sensitive and rational part of Matter know better how to make a Bee, then a Bee doth how to make Honey and Wax? or have a better communication betwixt them, then Bees that fly several ways, meeting and joyning to make their Combes in their Hives? (Cavendish 1664, 152–153).

Humans mistake Nature's truly wise actions for something like their own "gross actions," not understanding them to be unconstrained and peaceful. Nature's actions, like epigenesis, produced their effects by an "easie connection," without the "jolts" and other problems human beings would encounter in creating anything step by step. This becomes a main reason for Cavendish to argue that such productions must, in truth, be based on reason: for if there was reason in our own inferior productions, then there must, perforce, be superior reason in natural production (as in the production of the bee itself). Nature knows how to make a bee better than a bee knows how to make honey—a sentiment almost identical to what Harvey says about the superiority of "natural wisdom," e.g., the wisdom of spiders spinning webs and bees making hives (Harvey 1651, Ex. 50, 146). Without wisdom, no natural product could be made with such complexity and design, such harmony and order.

For Cavendish, Nature achieved its orderliness and regularity by prescribing that certain forms of behavior are appropriate for its various parts, which Karen Detlefsen has insightfully described as "norms" (Detlefsen 2007, 207). As mentioned above, Nature was a "Monarchess over all her Creatures," and had "Wisdom" by which she "orders and regulates her Corporeal Figurative Motions, into kinds and sorts of Societies and Conjunctions" (Cavendish 1668, 32). Importantly, as descriptions of natural causality, these were not so different from the ways Harvey described the soul in its relation to body. Cavendish's was a conception of natural causality as a relation between a leader and an organization,

something that can also be found in an unpublished manuscript of Harvey's called *De motu locali animalium* (1627), eventually published by the modern editor and translator of much of his work, Gweneth Whitteridge. There, Harvey asked a number of questions about the relationship between the seat of the soul (which, at this time he thought was the heart) and the rest of the body: "...is the heart the musician or the architect? The brain, the choir-master, surveyor. The nerves, clerks. The little nerves, controllers, prompters, directors. The muscles, singers, workmen, etc." (Harvey 1627 [1959], 151).¹⁷ Cavendish and Harvey thus saw living Nature acting as a kind of wise guide: Nature leads, directs, and sets down rules that bring about order and peace. The operations of Nature could be understood to be like the arts of human beings, in particular, the art of governance, as well as more traditional comparisons to technical productive arts like architecture. This was an appealing vision of Nature's action and wisdom for some post-Civil War English philosophers. Without such wisdom in natural productions, nothing like epigenesis could ever exist, just as, without a way to ground judgments in cases of disagreement, no civil society could exist. Epigenesis was thus linked to that desire I noted above, for to see Nature as wise and orderly was to find a profound source of harmony in a time bereft of such virtues.

These deep similarities, however, belie an important metaphysical difference. Each conceived the referent of "Nature" as having a different ontology, despite sharing a similar conception of the relation between Nature and Art. In particular, their ideas of body and its place in our account of the world were quite different. For Harvey, "Nature" referred to an essence, the "why," as it were, of a thing—its *propter quid* (Harvey discusses this in his letter to Riolan, Harvey 1649, 76). This essence was that which was summarized in a definition, namely, the reason for that thing's being—its *ratio*. The nature of the living blood, so important in his account of generation was, in particular, created by God to act "beyond its elements." That is, to act *rationally*, though the blood itself does not actually reason, at least, not in the same way that human beings do (more on this below). For Cavendish, meanwhile, "Nature" referred to "infinite and only matter," the plenum, which, in her mature works, consisted of rational, sensitive, and unanimate matter. Despite her rejection of mechanism, her natural philosophy was broadly materialist. There is a deep sense, then, that the objects of their natural philosophies were fundamentally different.

This is well illustrated by a passage from Cavendish's *Letters*. At the end of her (humorous) discussion of Harvey's ideas of generation, Cavendish mentioned Harvey's conception of the blood as the primary instrument of soul:

...whether the life of a Creature be onely in the blood, or whether it have its beginning from the blood, or whether the blood be the chief architect of an animal, or be the seat of the soul; sense and reason, in my opinion, doth plainly contradict them; for concerning the blood, if it were the seat of the Soul, then

¹⁷ I quote here from Whitteridge's translation (Harvey 1981). There are numerous possibilities for interpretation here, and Harvey describes several, including hearts as generals, brains as kings, and so on: 147–153. This is a pretty standard trope, found not just in medical authors, but also in the work of Francis Bacon (for which point I thank an anonymous reviewer).

in the circulation of the blood, if the Soul hath a brain, it would become very dizzie by its turning round... (Cavendish 1664, 432).

It is clear that Harvey's natural philosophy was, for Cavendish, absurd, at least in some respects, a result, in part, of their differing metaphysical and ontological assumptions. Cavendish here misunderstood Harvey's theory but, in so doing, she has actually demonstrated how alike their explanations of generation ended up being.

That is, despite her mocking of Harvey, we can find a deep and important connection in how the specter of teleology overshadowed their disagreement. Cavendish's mistake was to think that the "soul" that Harvey had located in the blood was equivalent to the brain. In fact, Harvey's philosophy was closer to that of an Eclectic Renaissance Aristotelian than to those canonical to the Scientific Revolution like Descartes or Boyle. Harvey, as an Aristotelian, could understand immanent teleology, and, as noted above, his account of epigenesis and soul depended heavily upon natural ends towards which the operations of natural things are directed. (This is not to say that Aristotelians agreed about teleology, or that Harvey's views were standard or doctrinaire—there was a great deal of diversity on this subject.) this was a For Cavendish, as for many others post-Descartes, teleology, if it could be said to exist, could only do so in terms human cogitation. That is, the only ends in nature were the ends of thinking, reasoning beings. If there were any determinate ends in nature, they must perforce be the intentional ones of minded things, even if this entailed that all of matter must be minded Harvey did not see natural ends as necessarily intentional. This amounts to a wholesale rejection of the Aristotelian notion of the soul, for it makes no sense outside a system with natural teleology. For Cavendish, the soul had become the mind.

Thus, when considering Harvey's work, she mistook his locating of the vegetative soul in the blood for locating the *mind* there, a non-starter on account of the fact we'd all be sick from the constant whirling of the circulation. While for Cavendish rationality was not limited to the brain or any organic part—for, indeed, on her account, all of matter is in some part rational—the soul, as the intelligence and reasoning aspect of the body of a person, must be some material aspect of the organic body. Her misunderstanding in the passage above, then, was in keeping with the overall trajectory of seventeenth century natural philosophy in Europe, one that moved towards analyzing material components, and that saw much explanation of Nature reduced to matter in motion.

Despite this, admittedly fundamental, difference in their ideas of Nature, both Harvey and Cavendish argued that it was rational. We must, however, be careful, for Harvey argued that, while it was true that epigenesis displays actual foresight and reason, the reason found here was a by-product of God's Wise Design. That is, Harvey seemed to lean heavily on analogy, seemingly stopping short of attributing rationality directly to natural objects. So, writing about the blood in the construction of the embryo, he noted that it, "...acts beyond the powers of the elements...it fashions the remaining parts of the body in due order, and that with the greatest foresight and understanding, acting towards a certain end as if it exercised some

power of reason...” (Harvey 1651, Ex. 71, 247–248).¹⁸ Harvey is usually careful to say that the blood acts *as if* it has thought and prudence, without ever going so far to say that it does actually have foresight.

However, I think Harvey ended up not so far from Cavendish. For while it was true that the vegetative soul, in neither blood nor semen, could be said to act with actual foresight, I think we should take this to mean that it does not act in the same manner as humans do when constructing things by Art. This is similar to what Cavendish described as the rationality of Nature: like human rationality, but importantly different, too. Harvey should be seen as invoking some version of Renaissance doctrines about Aristotelian Natures, but with a very important difference: he described the power of the vegetative faculty as not just having the ability to, say, generate the fetus, but as actually displaying *wisdom and foresight*. It was upon precisely this point that Harvey turned to natural theology: we should understand his recourse to God designing the Nature of the vegetative soul to act in such wise ways as a response to a long-held problem of Aristotelian philosophy, namely, the problem of how to understand final causality (Goldberg 2013). So, the natures and activities of vegetative “rationality” for Harvey, and rational matter for Cavendish, were both quite different from normal human processes of rationality as expressed in (say) artistic production. Both invoked the idea of Art in order to help explain epigenesis, but their commitment to a literal correspondence between human artistic production and natural generation was limited because the Nature of rationality in each instance was quite different, as too were the complexity of the products so produced.

Where Harvey leaned heavily on natural theology, however, Cavendish made a radical move: to put it in Aristotelian terms, Cavendish would aver that the blood really does know the final cause, and thus acts in accordance with that end. Of course, Harvey’s theological picture was different from Cavendish’s, though both had a rather ecumenical view of God, no doubt, again, a consequence of the Civil War.¹⁹ So, though their conceptions of matter, of cause, and of philosophical method were quite different—even incompatible—there was deep agreement between them in their characterizations of Nature’s wisdom and good design.²⁰ Harvey and Cavendish belied a common conception of the rationality of Nature, one bound up with age-old problems of understanding teleology in Nature. Indeed, they were part of a long tradition in which Nature’s wisdom was seen as both fundamental to explanation as well as obvious upon observation.

While Harvey clearly did not think that matter had any activity or intelligence *qua* matter, he was certain that ensouled matter did have activity and, as the case of epigenesis made clear, intelligence. Indeed, as Christopher Hill has argued, there

¹⁸ ...supra vires elementorum agit...reliquas totius corporis partes ordine fabricat; idqua summa cum providentia and intellectu, in finem certum agens, quasi ratiocinio quedam uteretur.

¹⁹ On Cavendish and religion, see Walters (2014), and Sarasohn (2010) (especially 35–36). On Harvey’s theology (or what we might make of it), see Goldberg (2013).

²⁰ It’s important to note here that Cavendish needed rational matter not just to explain living things, but, in fact, to explain *any cause whatsoever*. See Detlefsen (2007, 188).

was a whiff of mortalism to Harvey's doctrine of the blood.²¹ That is, even though Harvey was never accused of such, he was associated with thinkers who had held a variety of materialist conceptions of the soul that flatly contradicted traditional doctrines, such as Michael Servetus (Hill 1964, 62–63). Thus, Harvey's doctrine of the soul in the blood, misunderstood as Cavendish has done, could not help but be seen in the context of profound religious and political disputes occurring in England at the time. Expressing and describing Nature as rational, as ordered and wise as Harvey does, as capable even of negotiation and agreement as Cavendish does, was thus linked to the political atmosphere of mid-century England. This is not to argue that such politics determined natural philosophical explanations, only to suggest that there was a connection, even if only in the manner of presentation, even if only in the desire for a real source of consensus and peace.

We can thus see Harvey's and Cavendish's explanations of generation as an important episode in the centuries-long arbitration over the meaning and implication of soul and reason in a material world. Here we find, in particular, that epigenesis played an important role in both determining what needed to be explained, as well as confounding and placing pressure on existing accounts of explanation. In the specific context of post-Civil War England, the implication that Nature was self-ordered and harmonious was seductive. Political and scientific experience thus came together in a desire to see in Nature a source for order, a source that offered not just epistemic benefits, but also, perhaps, civil and social ones too.

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²¹ Hill (1964). See also Thomson (2008): “The most common form of seventeenth-century Christian mortalism claimed that the whole individual died and was insensible until the resurrection and judgement, when the whole individual would be resuscitated and enter on eternal life. There was no continuation of an immaterial part of the individual, no feeling, thought, or suffering before the final general resurrection” (42). See also: Pagel (1967, 136ff.), and Wolfe and van Esveld (2014).

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